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PATENT SPECIFICATION

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(54) A GRAIN PEARLING MACHINE

(71) We, IONY KABUSHIKI KAISHA, a Japanese joint stock Company, of 16/2, Shinkawa 6-chome, Mitaka-shi, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a grain pearling machine, and more particularly, it relates to a rice pearling machine.

Rice pearling operations can be classified into two groups, viz., the one for obtaining polished rice which is suitable as boiled rice and another for obtaining polished rice for the brewing of the alcoholic drink called sake. In obtaining polished rice for boiled rice, brown rice is polished so as to remove therefrom bran which covers the surface of brown rice and also to strip therefrom embryos which are bad for the health. In obtaining the polished rice for sake brewing, polishing of brown rice continues further, until its bran and embryos are completely removed and stripped, so as to expose the core thereof which largely consists of layers rich in starch.

In practice, polished rice for boiled rice is obtained by a horizontal shaft and friction rice pearling machine of the kind illustrated in Fig. 1 of the drawings. The brown rice supplied from an inlet B into the machine is propelled into a pearling chamber D by means of an auger C, and agitated in said chamber by an agitating rotor A whereby the rice is subjected to the friction produced therebetween and is pearled. It shall be noted that over an outlet F there is provided a resistance cover plate G which gives a considerably large resistance against the flow of rice within the pearling chamber. In other words, the brown rice within the pearling chamber is subjected to friction under a pressure which is produced between the grains of rice, whereby bran and embryos are instantaneously removed and stripped and they are discharged from the machine by means of a cylindrical screen E. This means that a single pass of the brown rice in the machine from the inlet B to the outlet F can achieve the complete pearling of the rice. Unusually, the brown rice is passed through the machine two or three times so as to have finely pearled rice. However, irrespective of the number of times of passing the rice through the machine, it is inevitable to obtain a certain percentage of cracked rice, because the pearling operation with a machine of the said kind is done roughly under a high pressure so that the grains are subjected to stress.

Production of cracked rice can largely be prevented if a pearling machine is of the vertical shaft type. The vertical shaft pearling machine generally comprises a pearling rotor made of an emery stone and extending vertically with respect to a pearling chamber, said pearling chamber making in cooperation with the pearling rotor a comparatively wide annular passage for brown rice, an inlet located at an upper portion of the machine, and an outlet located at a lower lateral side of the machine. Within a machine of the kind mentioned above in which the pearling rotor is rotated at a high velocity, the brown rice introduced thereinto is repulsed by the rotor whenever it touches the rotor, whereby the rice is rotated even more rapidly on its axis and also about the rotor in substantially horizontal directions, and is polished gradually, portion by portion of its surface, each time when the rice touches the rotor while it flows downwardly by its gravity, and it is discharged finally from the outlet by centrifugal force. In this pearling operation, the brown rice is gradually pearled while it is rotated freely, not under

pressure, within a pearling chamber so that scarcely any cracking of the rice occurs. However, this kind of pearling has a drawback in that pearling efficiency at a single pass is low. As the brown rice supplied into a pearling chamber is subjected loosely to the pearling without being heavily packed within the chamber, the rice discharged from the outlet although scarcely cracked has also been but little pearled after its single pass. It should be understood that if the rice is heavily packed within the pearling chamber of this kind, the rice can hardly rotate whereby the centrifugal force is diminished and the rice can not be discharged by said force. Though the pearling of rice by means of a vertical shaft pearling machine is low in its operational efficiency, it is advantageously employed in a sake brewery because the cracking of rice is small. In fact, in almost all sake brewery plants, there are installed 40 to 60 units of vertical shaft rice pearling machines which are located in series; only when brown rice has passed through all of these units is it pearled adequately to be suited for sake brewing.

A grain pearling machine according to the present invention comprises at least one vertically extending pearling chamber, a driving shaft extending through said pearling chamber coaxially therewith, the said shaft being fitted with a pearling rotor having the shape of a cylinder or truncated cone which rotates integrally with the shaft, the said chamber being provided at its circumferential wall with screens which discharge the bran produced in the chamber and said wall being spaced from the rotor at a predetermined distance, a supply inlet of the grain into the pearling chamber opening above said chamber, an outlet opening below the rotor and about the axis of the driving shaft, and resistance means movably closing said outlet according to the weight of the grain held in the chamber.

By means of the machine of this invention, in which a vertical shaft is employed, a high yield of good rice is obtainable comparable to the yield of conventional vertical shaft rice pearling machines, and also the pearling operation is done at such high efficiency as to be comparable to that of conventional horizontal shaft rice pearling machines.

In the accompanying drawings:

Fig. 1 is a vertically sectioned side view of a conventional horizontal shaft rice pearling machine;

Fig. 2 is a vertically sectioned side view of the rotor portion of a horizontal shaft grain pearling machine made in accordance with this invention;

Figs. 3 to 6 are vertical sectional views of an entire machine in accordance with this invention;

Figs. 7 and 9 are vertical sectional views of another machine in accordance with the invention;

Fig. 8 contains fragmentary side sectional views of major parts of the embodiment of Figs. 7 and 9; and

Fig. 10 is a sectional side view of a further type of machine in accordance with this invention.

We refer first to Fig. 2 in which machine a shaft 1 is mounted vertically (contrary to Fig. 1 which has been described above wherein the shaft is horizontal). A driven pulley 2 is fixed to the upper end of the shaft. To the lower end of said shaft 1, there is fixed a pearling rotor 3 which has the shape of a cylindrical roller. Numeral 4 indicates a bran screening cylinder which surrounds the pearling rotor circumferentially thereto and coaxially therewith. An annular pearling chamber 8 is thus formed between the outer surface of the pearling rotor 3 and the inner surface of the screening cylinder 4. The pearling chamber communicates with an inlet 5 from which grain is supplied into the said chamber 8. Outlet 6 is loacted under the shaft 1 and is coaxial with the vertical axis X-X of the shaft, and has an opening of a diameter smaller than the diameter of the pearling rotor 3; this opening is in the horizontal plane Y-Y. A resistance means 7, which is movable vertically, is provided under the outlet so as to produce an adequate resistance load within the pearling chamber 8. Numeral 9 indicates a helical projection from the roller, which assists agitation of the grains.

With this construction, even when rice is heavily packed within the pearling chamber 8 under a comparatively strong resistance given by the resistance means 7, the grain is smoothly discharged and smoothly pearled, due to the brown rice supplied from the inlet 5 being agitated by the projection 9 of the pearling rotor.

In Fig. 2, it is indicated by arrows that the grain is sometimes repulsed upwardly by the agitating projection, but such repulsion is not essential for the operation of this invention machine though it is preferable. When the pearling rotor rotates at a certain high velocity, the brown rice also horizontally revolves and is subjected to pearling, while the discharge of rice from the pearling chamber is retarded on account of the resistance means or plate 7. This means that in the upper half of the pearling chamber 8, the grain is pearled while it is loosely packed in the chamber, whereas at the lower half of the chamber, the rice is closely packed. In other words, as the rice heavily occupies the lower half of the pearling chamber, it cannot revolve

but it is subjected to effectively strong pearling due to the pearling rotor 3 rotating at a high velocity. Though it is described above that the lower half of the pearling chamber is heavily packed with the rice in Fig. 2, the packing condition of grain in Fig. 2 is different from that of Fig. 1. In Fig. 1 the rice is packed into dense layers by means of a screw auger which forcibly propels the rice, whereas the rice within the pearling chamber of Fig. 2 is maintained in a packed condition at its lower half by means of the resistance means 7 which can withstand the weight of the rice of one half of the pearling chamber. In other words, as the packing of rice within the pearling chamber in the present invention is not made under an applied pressure but by its own gravity, there is no danger that the rice will be cracked. In addition, it shall be noted that at the outlet 6 is located right under the center of pearling chamber 8, the discharge of rice from the chamber goes smoothly. The outlet 6 located against the pearling chamber at such a specific position as described above serves as a funnel for fluidly discharging the grain from the pearling chamber.

The pearling rotor 3 which in the aforesaid Fig. 2 has a cylindrical shape, as the first embodiment of the invention, can alternatively be shaped as an inverted truncated cone the diameter of which gradually increases towards the top. By this configuration, the upper half of the rotor can have a higher peripheral velocity compared to the lower half, whereby it can propel the rice loosely packed, while the lower half of the rotor having a reduced diameter and consequently a lower peripheral velocity can agitate moderately the rice which is closely packed in the lower half of the pearling chamber. A smoother pearling operation is obtained when the shaft of the pearling rotor does not protrude downwardly beyond the rotor so that a wider passage can be kept for discharging the pearled rice.

As aforementioned, in a conventional vertical shaft rice pearling machine, a pearling rotor rotating at a high velocity makes the rice revolve horizontally and at a high velocity, whereby the rice is ground or frictionally pearled without losing its original shape. The rice thus subjected to the pearling operation is discharged by a centrifugal force through a discharge opening which is provided at a lateral side of a machine and in line with the direction of the centrifugal force. This means that as the rice is always kept in a loosely packed condition, a vigorous or highly efficient pearling operation can hardly be expected. If a resistance means acting at a discharge opening is made stronger so as to cause the rice to be packed within the chamber more densely and consequently to obtain a more efficient pearling operation, the grain located at a side opposite to the discharge opening becomes static and finally becomes packed, whereby the flow of rice is largely disturbed.

The present invention can provide, as described above, a rice pearling machine which can pearl the rice most efficiently even in a densely packed condition, on account of a novel location and arrangements of its discharge opening, though the machine is provided with a pearling rotor shaft mounted vertically which has been considered not suitable for obtaining pearled rice for boiled rice.

In the following, three embodiments of this invention are explained in detail, in which in the first embodiment illustrated in Figs. 3 to 6 the rotor is of the grinding or abrasive type, the second embodiment illustrated in Figs. 7 to 9 is of the friction type, and the third embodiment illustrated in Fig. 10 is the friction type accompanied by the grinding type.

Firstly, with reference to Figs. 3 to 6 in which the first embodiment of this invention is illustrated, to lower base frame 10 there is mounted an upper base frame 11, to the upper opening of which an upper cover plate 12 is fitted so as to close said opening. The upper cover plate 12 has at its center a circular opening 13. A supporting fixture 14 is provided to the cover plate 12 so as to protrude above the opening 13. To the supporting metal fixture 14 at its upper central portion, there is fixed a bearing 15, while to the lower portion of the opening 13 there is fixed another supporting fixture 20 which is in turn fixed with another bearing 21 (Fig. 6). A rotary shaft 1 is rotatably supported by said two bearings 15 and 21 in the manner of a cantilever and extends vertically. A motor 16 fixed to the supporting fixture 14 at its upper lateral side and having a driving pulley 17 is operatively connected with the driving shaft 1 by means of a driven pulley fixed to the upper part of said shaft and an endless belt mounted over said two pulleys. Obliquely upwardly to the cover plate 12, there is located a supply hopper 23, the supply inlet 5 of which opens at a side of a tubular wall which surrounds the rotary shaft 1. There is provided, slightly under the said tubular wall, a conical means 22 which serves to spread the rice radially outwardly. Said conical means is insertedly fitted to the rotary shaft 1 above the opening 13. The shaft 1 is thus hung vertically so as to pass through the center of the opening 13 of the cover plate 12. The lower part of the shaft 1 extends through the longitudinal axis of the upper frame, and is insertedly fitted with a frame 25, to which the pearling

rotor 3 is fixed (Fig. 6). The upper end 26 of the frame 25 abuts against the lower surface of the lower bearing 21, and the lower end 27 of the said frame 25 is fastened with a nut 28 which is threadedly fitted to the lower end of the shaft 1. The aforementioned pearling rotor 3 made of an emery stone has a configuration of an inverted trauncated cone having a diameter gradually increasing towards its top, whereby the upper portion having a larger diameter has a larger peripheral velocity and the lower portion having a smaller diameter has a lower peripheral velocity. This pearling rotor 3 is circumferentially surrounded with a bran screening cylinder 4. A base frame 29 which is fitted to the lower end of the upper frame 11 and fixes the lower part of the screening cylinder 4 has at its center a discharge opening 6. Said discharge opening is surround by an annular opening 30. The location and arrangements of the discharge opening 6 have been described in detail with reference to Fig. 2. However, it shall be reiterated that the discharge opening has a smaller diameter than the pearling rotor 3, and has a configuration similar to a funnel. There is formed, between the outer circumferential surface of the screening cylinder 4 and the inner surface of the upper frame 11, a bran discharge chamber 31 which communicates with, through the annular opening 30, a suction device 33 which is provided to a lateral wall of the lower frame 10. Numeral 34 indicates a projection extending downwardly from the base frame 29. This projection 34 pivotally supports an intermediate portion of an operating lever 35 which, in turn supports, at one of its ends a resistance means 7. To another end of the lever 35, there is fitted a weight 36. Numeral 32 indicates a cyclone.

With reference to Figs. 7 to 9 which illustrate the second embodiment of this invention, as described above, and in which those parts identical with or similar to the parts of the first embodiment are represented by the same numerals, a friction type rice pearling machine made in accordance with this invention is briefly described hereinunder.

In this embodiment, about one or two threadly extending projections 9 are preferably provided on an outer surface of the pearling rotor 3 for giving brown rice a component force that impels the rice slightly upwardly. The pearling rotor in this embodiment is hollow, and has air slits 37 which open beside the projections 9. The shaft 1 in this instance is also hollow. Ambient air sucked from the shaft 1 is blown out from the air slits 37. By contrast to the first embodiment in which the rotor 3 and screening cylinder 4 are conical, they are cylindrical in this embodiment. And, also, differently to the first embodiment, the conical means 22 is eliminated in this embodiment, because in this embodiment, pearling is done by friction.

In the third embodiment which is illustrated in Fig. 10, a pearling machine having two rotors in which the first and second embodiments are combined, is illustrated. The parts are represented by those numerals indentical with those of the first and second embodiments. In this embodiment, the brown rice is subjected to a frictional pearling operation successively to the grinding or abrasive pearling operation.

WHAT WE CLAIM IS:

1. A grain pearling machine, which comprises at least one vertically extending pearling chamber, a driving shaft extending through said pearling chamber coaxially therewith, the said shaft being fitted with a pearling rotor having the shape of a cylinder or truncated cone which rotates integrally with the shaft, the said chamber being provided at its circumferential wall with screens which discharge the bran produced in the chamber and said wall being spaced from the rotor at a predetermined distance, a supply inlet of the grain into the pearling chamber opening above said chamber, an outlet opening below the rotor and about the axis of the driving shaft, and resistance means movably closing said outlet according to the weight of the grain held in the chamber.

2. A grain pearling machine as claimed in claim 1, in which the pearling rotor is an inverted truncated cone having a diameter gradually increasing towards the top.

3. A grain pearling machine as claimed in claim 1, in which the pearling rotor is cylindrical with a projection threadedly extending on its circumferential wall.

4. A grain pearling machine as claimed in claim 1, 2 or 3, in which the driving shaft does not appreciably project from the bottom of the pearling rotor.

5. A grain pearling machine as claimed in any preceding claim, in which the machine comprises two pearling chambers vertically communicating with each other and respectively provided with a pearling rotor, the driving shaft being common to the pearling rotors in the first and second chambers, and the resistance means is provided to the outlet opening of the second chamber.

6. A grain pearling machine as claimed in claim 5, in which the pearling rotor in the second chamber is as defined in claim 4.

7. A grain pearling machine, substantially as hereinbefore described with reference to Figures 2, 3 to 6, Figures 7 to 9, or Figure 10 of the accompanying drawings.

8. Grain, whenever treated in a pearling machine as claimed in any preceding claim.

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FIG. 1

PRIOR ART

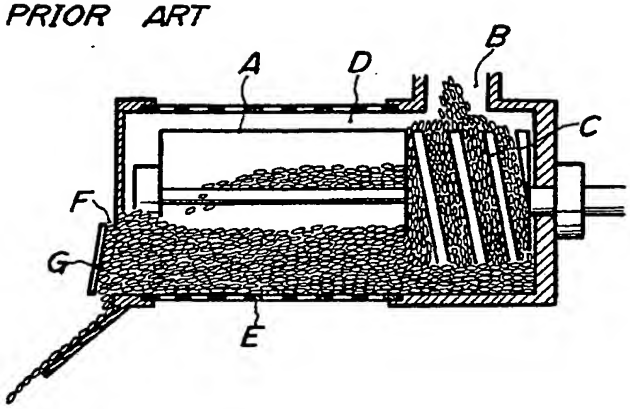


FIG. 2

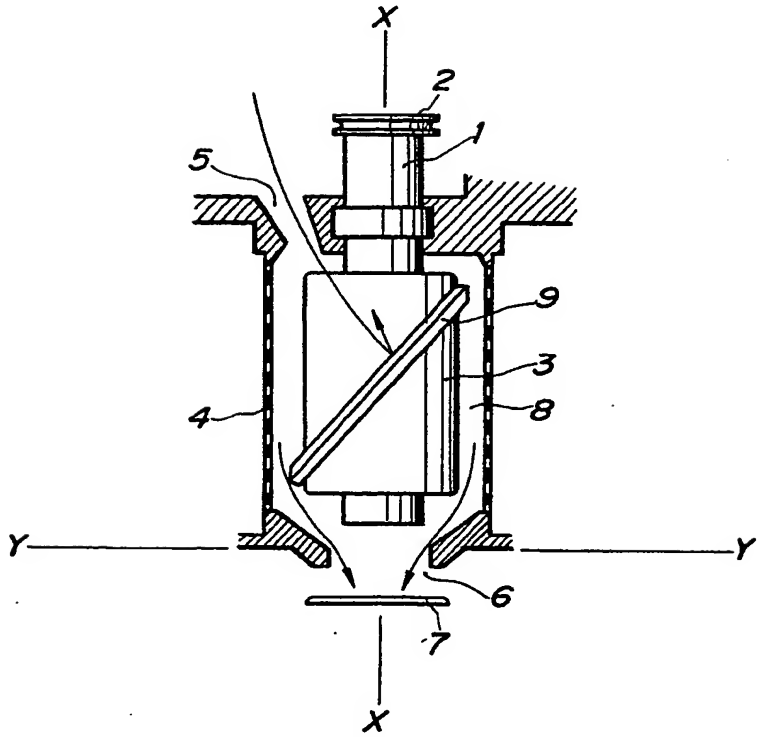
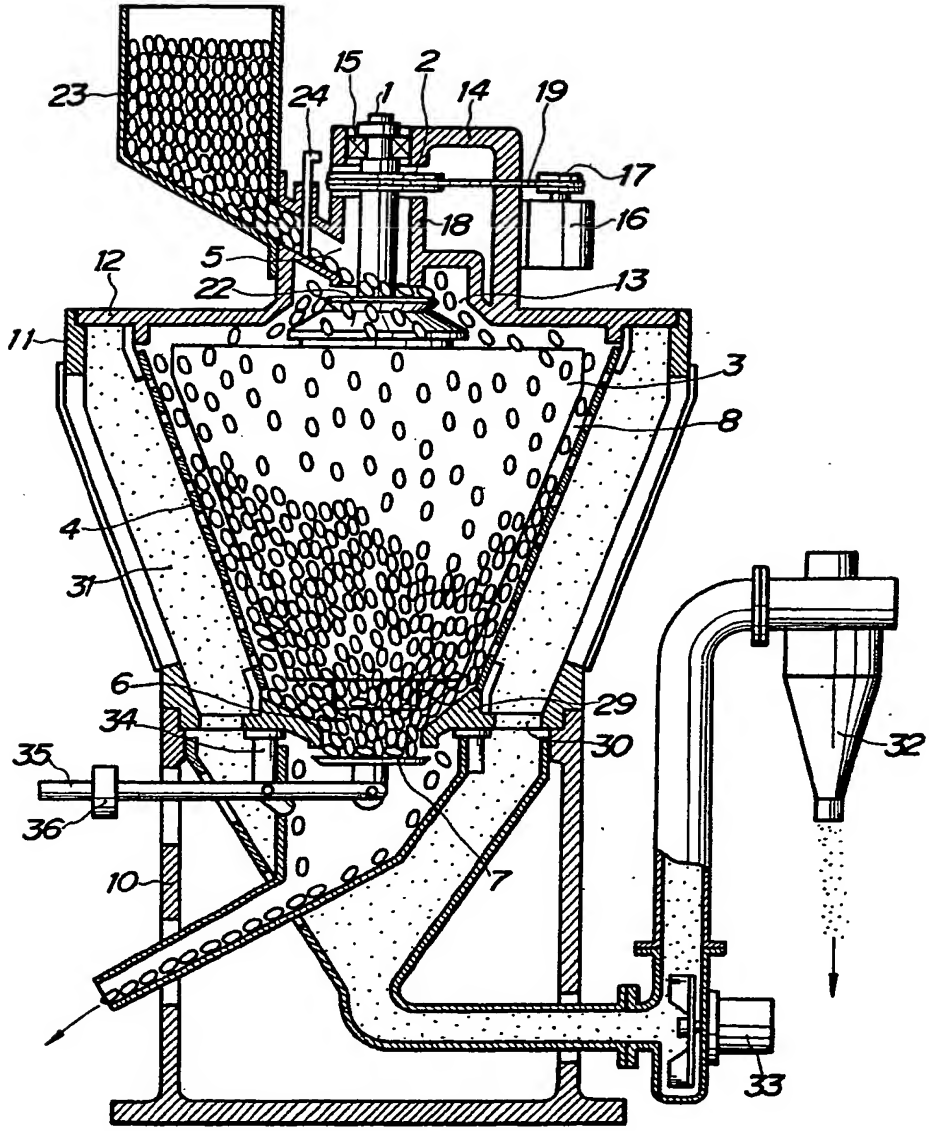


FIG. 3



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SHEET 3

FIG. 4

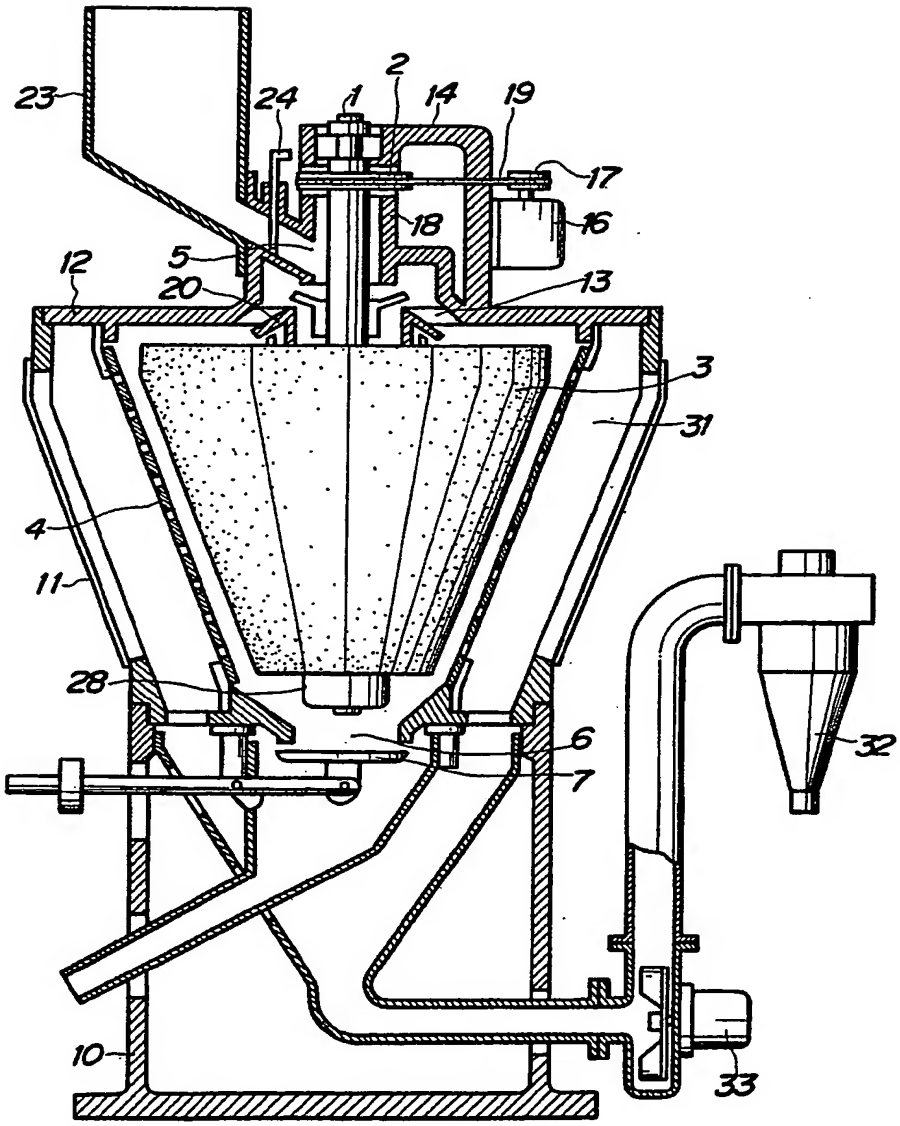
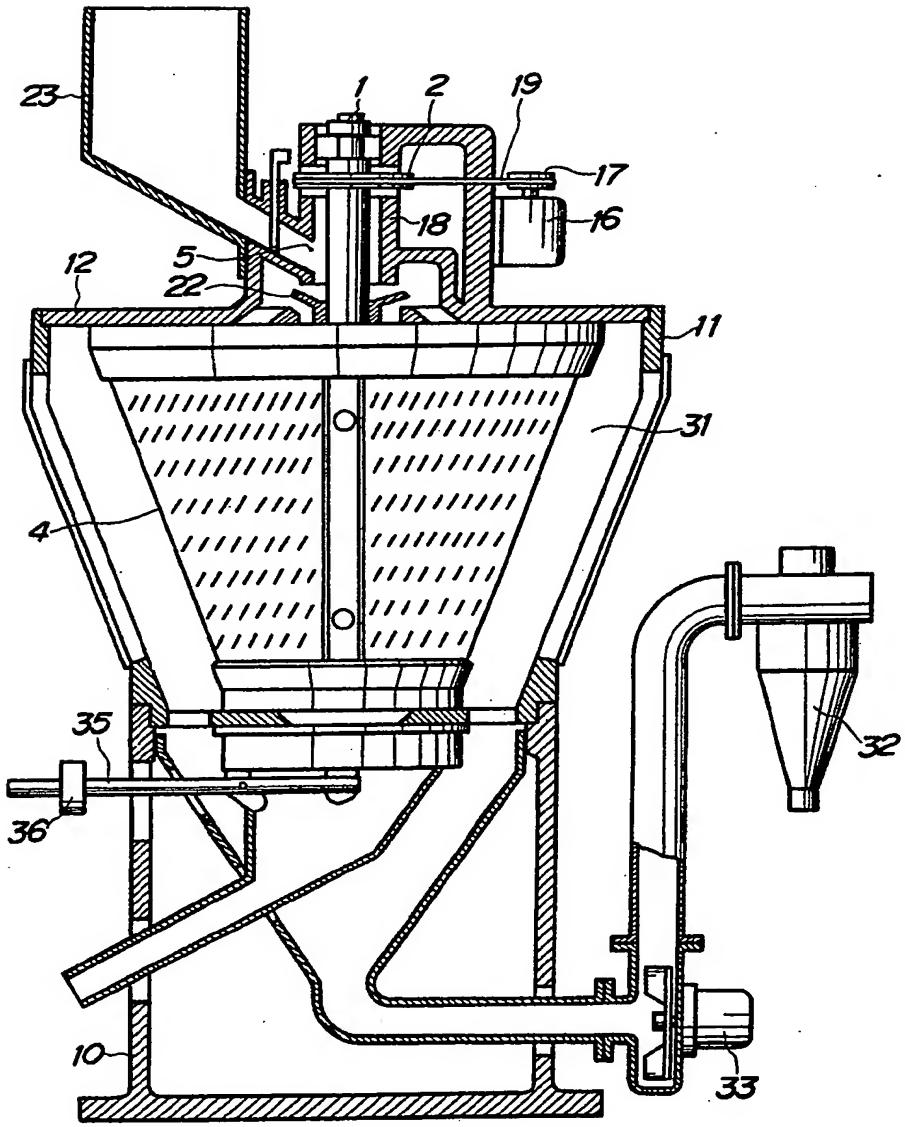


FIG. 5



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COMPLETE SPECIFICATION

FIG. 6

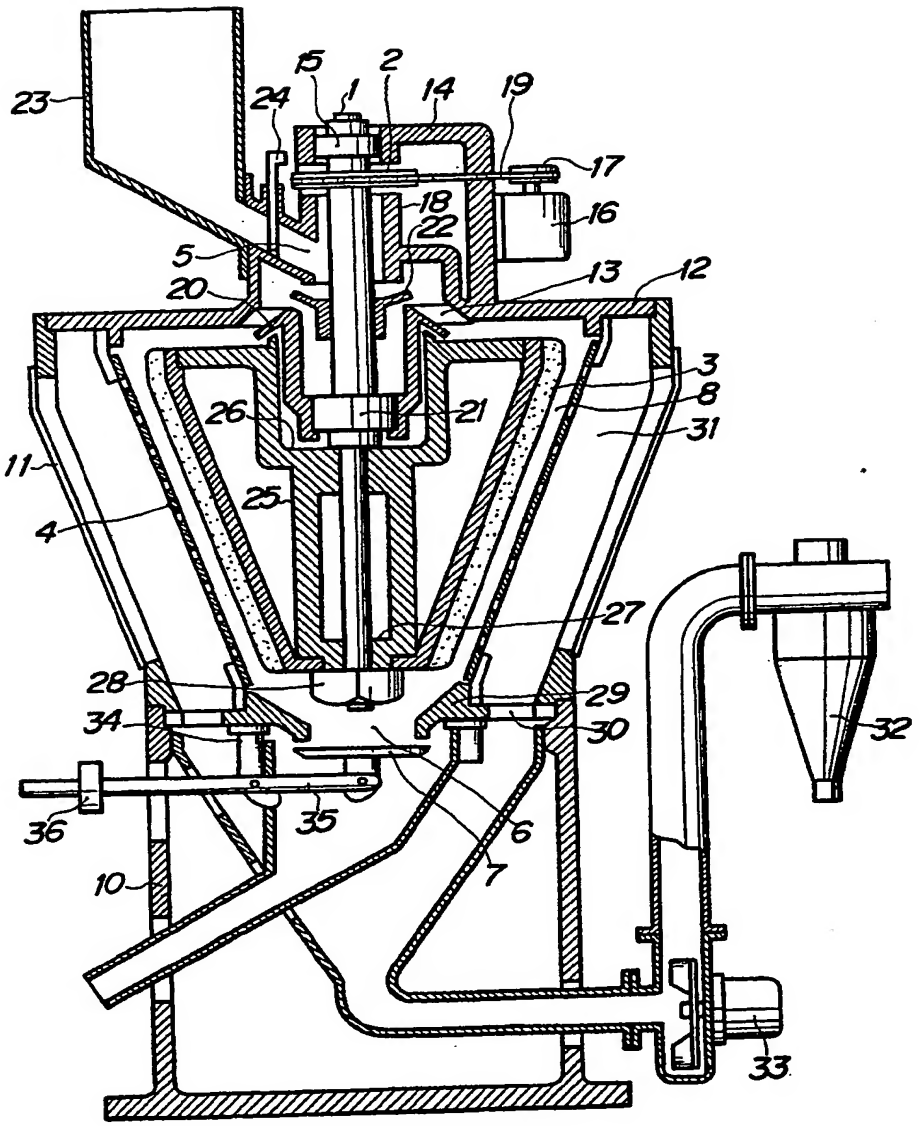
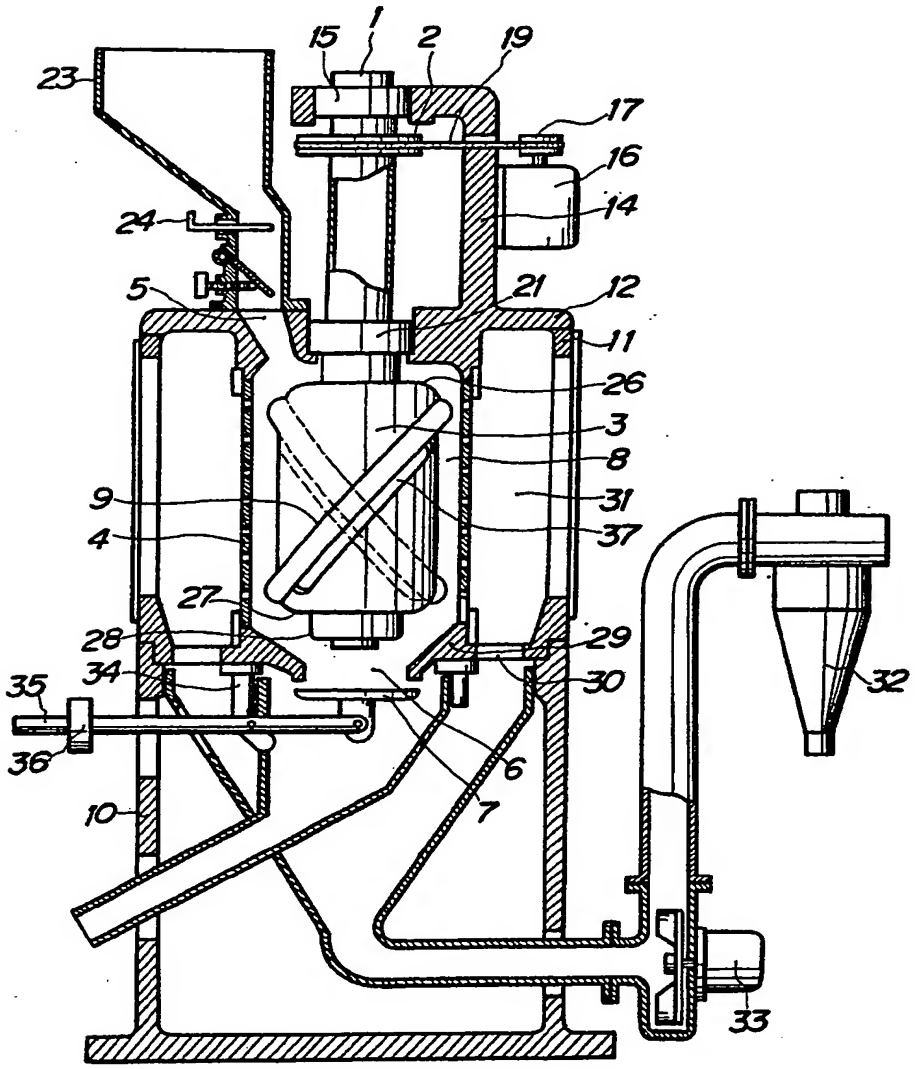


FIG. 7



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SHEET 7

FIG. 8

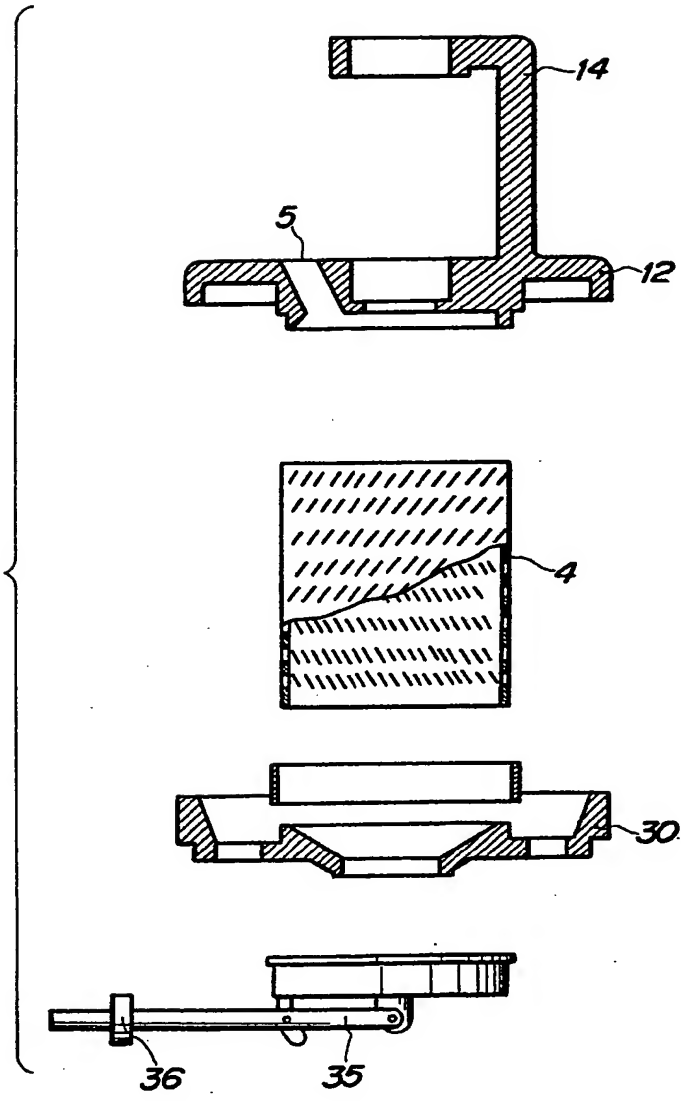

FIG. 9

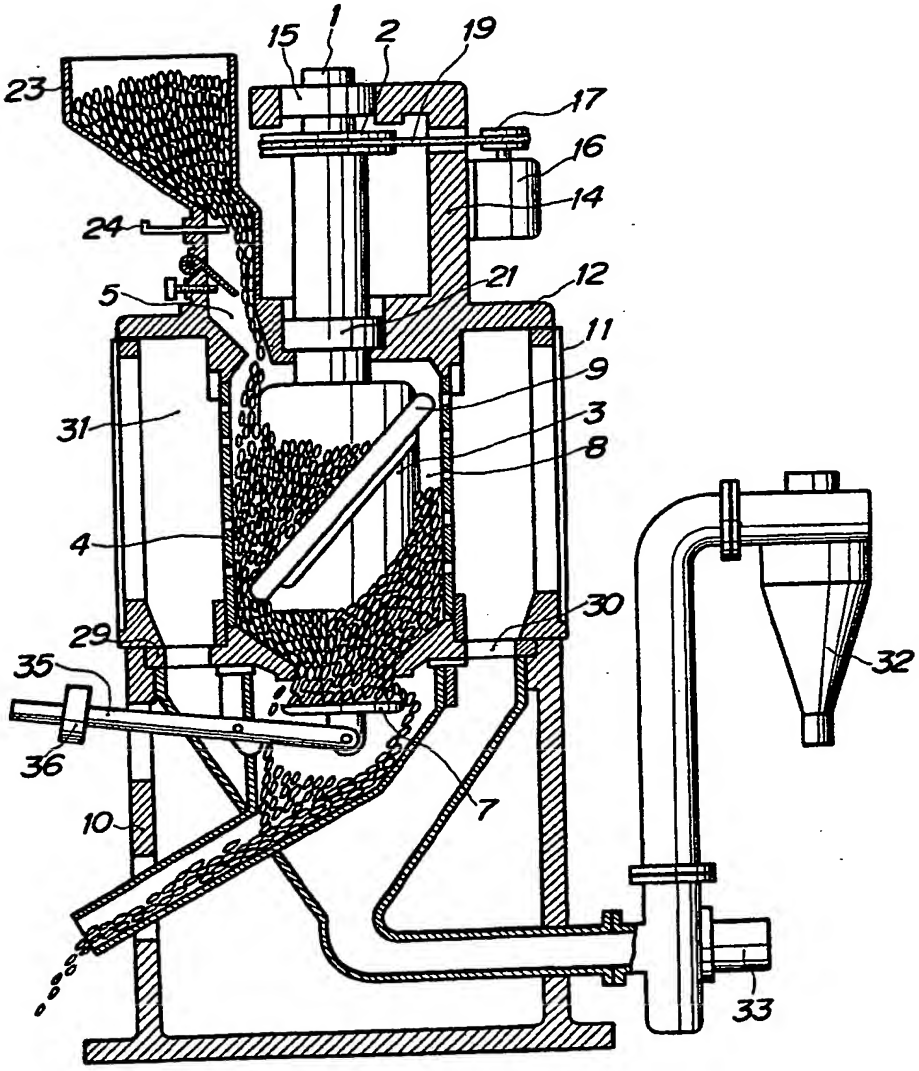

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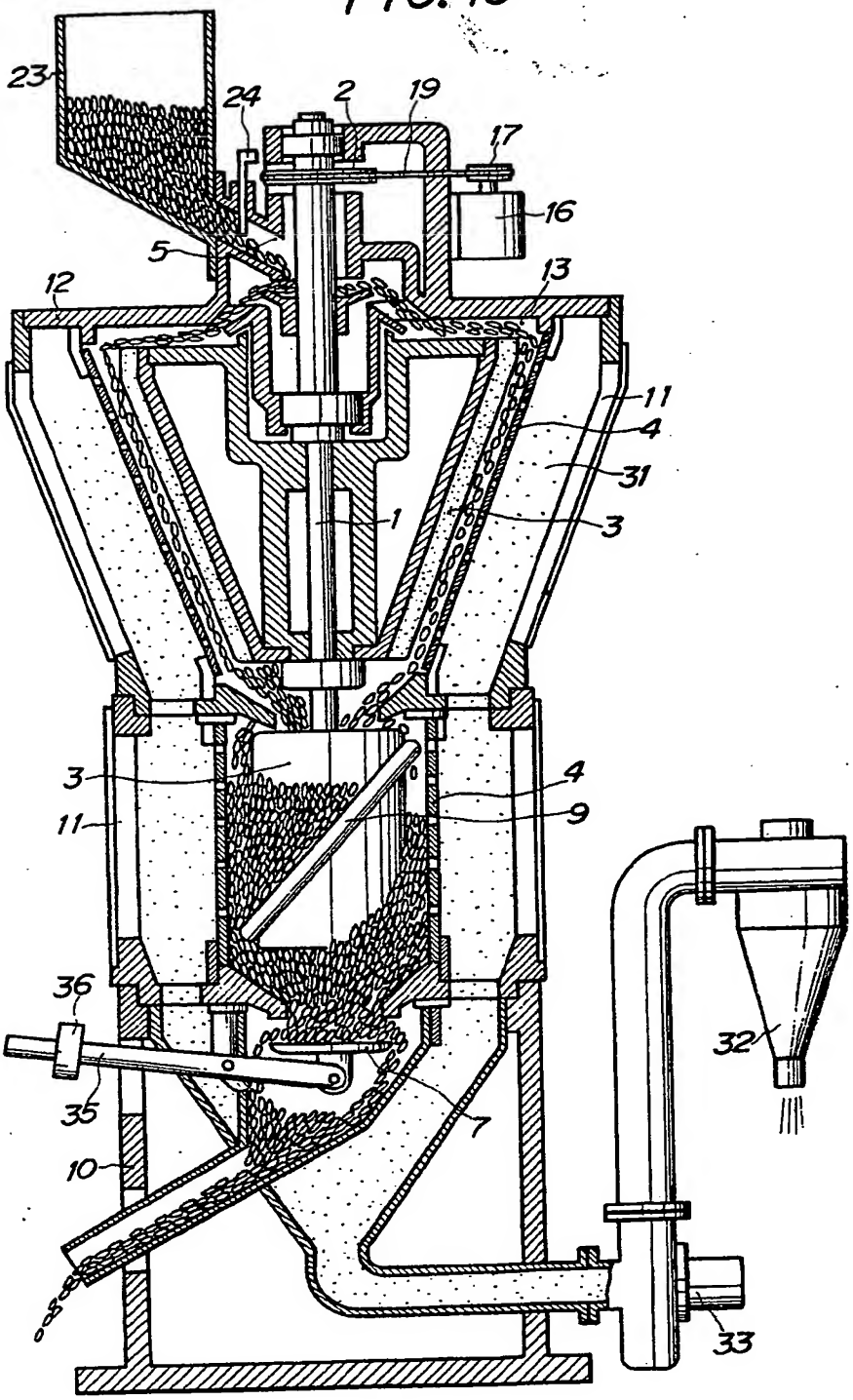
FIG. 10



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